

# Rapid Analysis and Manufacturing Propulsion Technology (RAMPT)

Completed Technology Project (2017 - 2022)



## Project Introduction

The Rapid Analysis and Manufacturing Propulsion Technology (RAMPT) project is maturing novel design and manufacturing technologies to increase scale, significantly reduce cost, and improve performance for regeneratively-cooled thrust chamber assemblies, specifically the combustion chamber and nozzle for government and industry programs.

There are three key technologies:

1. Develop composite over-wrap technology for regen-cooled TCA with specialty manufacturing vendor.
2. Develop large-scale freeform laser directed energy deposition technology for forming regen-cooled nozzle components with specialty manufacturing vendor.
3. Develop bimetallic joints for integration of the manifolds to a copper-alloy chamber with specialty manufacturing vendor.

RAMPT is an integrated NASA/private industry partnership developing and integrating modern manufacturing techniques into a single thrust chamber assembly, characterizing these specialty manufacturing processes, disseminating material/process design data, and completing hot-fire testing to demonstrate a multi-metallic additive-based composite overwrap thrust chamber assembly.

## Anticipated Benefits

RAMPT benefits include: Reduced cost, manufacturing schedule, scale and improved performance of a regeneratively-cooled thrust chamber assembly (combustion chamber and nozzle) for government and industry propulsion applications.

**Freeform blown powder nozzle:** The first key technology being matured under RAMPT is the freeform blown powder deposition additive manufacturing of the large scale regen-cooled nozzle structure. The goal of this process development is to advance the blown powder deposition for large scale thin-walled structures to net shape or near-net shape to significantly reduce the time required for nozzle fabrication.

**Composite overwrap structural jacket:** The second key technology being developed under RAMPT is the composite overwrap of the thrust chamber assembly (TCA). The TCA includes the combustion chamber liner manufactured from a GRCop84/42 copper-alloy based material and the freeform nozzle manufactured using super alloy materials. This technology offers the potential to substantially decrease weight up to 70 percent over metallic jacket structural supports.



Rapid Analysis and  
Manufacturing Propulsion  
Technology

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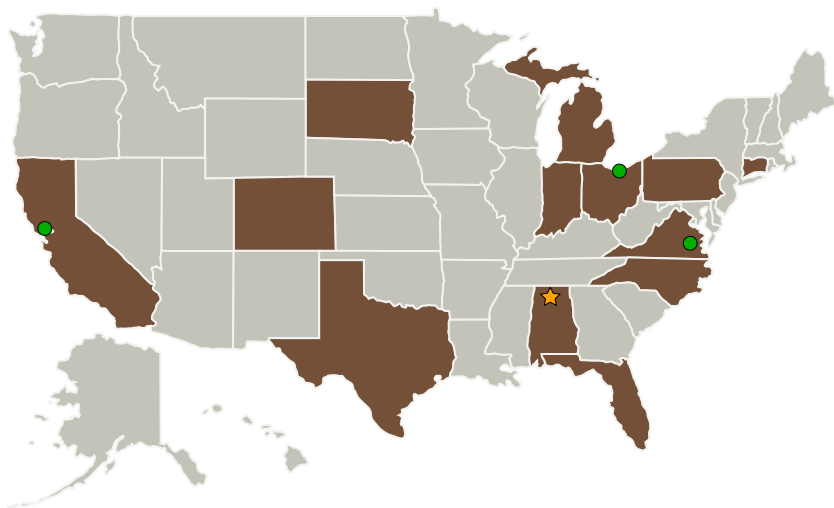
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Bimetallic radial deposition for manifolds: The third key technology area is the development of the bimetallic deposition for manifold land and/or integrated manifold to the GRCop84/42 combustion chamber.

Modeling and analysis tools for additive and regenerative design: The fourth key technology area is the development of congruent design and analysis tools that help optimize the overall design and fabrication process. This includes tools for process modeling and design tools that integrate various codes and analysis subroutines to allow for optimization of complex regenerative-cooled combustion devices components.

### Primary U.S. Work Locations and Key Partners



### Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Marshall Space Flight Center (MSFC)

**Responsible Program:**

Game Changing Development

### Project Management

**Program Director:**

Mary J Werkheiser

**Program Manager:**

Gary F Meyering

**Project Manager:**

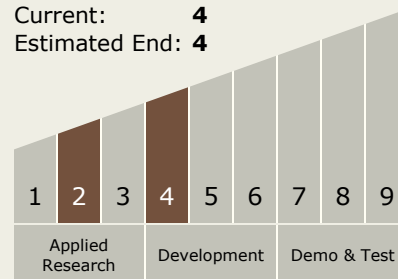
John C Fikes

### Technology Maturity (TRL)

Start: 2

Current: 4

Estimated End: 4





Organizations Performing Work	Role	Type	Location
★ Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
Additive Manufacturing & Engineering	Supporting Organization	Industry	Huntsville, Alabama
Addup	Supporting Organization	Industry	
Aerojet Rocketdyne 3D Material Technologies	Supporting Organization	Industry	
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Auburn University	Supporting Organization	Academia	Auburn, Alabama
DM3D Technology	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Auburn Hills, Michigan
EB Welding at PTR	Supporting Organization	Industry	
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
Heat Treating at Solar Atmospheres	Supporting Organization	Industry	

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## Technology Areas

### Primary:

- TX01 Propulsion Systems
  - ↳ TX01.1 Chemical Space Propulsion
  - ↳ TX01.1.3 Cryogenic

### Other/Cross-cutting:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing

## Target Destinations

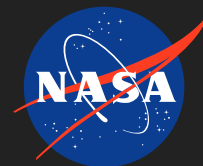
The Moon, Mars

## Supported Mission Type

Projected Mission (Pull)



Organizations Performing Work	Role	Type	Location
Keselowski Advanced Manufacturing	Supporting Organization	Industry	
Kord Technologies	Supporting Organization	Industry	Huntsville, Alabama
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
Magna Machining	Supporting Organization	Industry	
Material Testing at Stresstech	Supporting Organization	Industry	
Pinson Valley Heat Treating	Supporting Organization	Industry	
Precision Cleaning at TMC	Supporting Organization	Industry	
Quadrus Corporation	Supporting Organization	Industry	
RPM Innovations	Supporting Organization	Industry Women-Owned Small Business (WOSB)	Rapid City, South Dakota
Stratasys	Supporting Organization	Industry	
Surface Polishing at Rem Chem	Supporting Organization	Industry	
VRC Metal Systems	Supporting Organization	Industry	Box Elder , South Dakota
Westmoreland Mechanical Testing and Research	Supporting Organization	Industry	



Co-Funding Partners	Type	Location
Commercial Spaceflight Development Division	NASA Other	
Exploration Systems Development Division	NASA Program	
Game Changing Development(GCD)	NASA Program	

Primary U.S. Work Locations	
Alabama	California
Colorado	Connecticut
Florida	Indiana
Michigan	North Carolina
Ohio	Pennsylvania
South Dakota	Texas
Virginia	

## Links

Future Rocket Engines May Include Large-Scale 3D Printing

(<https://www.nasa.gov/centers/marshall/news/releases/2020/future-rocket-engines-may-include-large-scale-3d-printing.html>)

RAMPT project featured in Advanced Manufacturing Magazine (pg. 133)

([https://issuu.com/inovar-communications/docs/metal\\_am\\_autumn\\_2020?fr=sMWI2NzIwOTQwMDk](https://issuu.com/inovar-communications/docs/metal_am_autumn_2020?fr=sMWI2NzIwOTQwMDk))

## Project Website:

[https://www.nasa.gov/directorates/spacetech/game\\_changing\\_development/index.html](https://www.nasa.gov/directorates/spacetech/game_changing_development/index.html)